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METEOROLOGICAL DATA FOR THE TITAN 3C LAUNCH
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COMPENDIUM OF METEOROLOGICAL DATA FOR THE TITAN III C LAUNCH IN DECEMBER 1973

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Marshall Space Flight Center, Alabama*

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16. ABSTRACT All the meteorological data for the 19-hour period before the Titan III C (AF-777) launch from Kennedy Space Center at 1857 EST on December 13, 1973, are archived at the Marshall Space Flight Center. These data were collected in support of the NASA rocket exhaust effluent prediction and monitoring program. This data set is unique in that soundings were made with a high temporal resolution. All supporting data, such as synoptic charts and surface data, are also included. This is the first in a series of seven data reports.			
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13 December 1557 EST (2057Z), T- 3 hr	23
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TECHNICAL MEMORANDUM X-73334

COMPENDIUM OF METEOROLOGICAL DATA FOR THE TITAN III C LAUNCH IN DECEMBER 1973

I. INTRODUCTION

This report is a compendium of all the meteorological data collected as a function of the Marshall Space Flight Center (MSFC)/Langley Research Center (LaRC)/Kennedy Space Center (KSC) rocket exhaust effluent prediction and monitoring program for the Titan III C launch (AF-777) from launch pad 40, Kennedy Space Center, at 1857 EST on December 13, 1973. The data presented in this compendium were collected largely to support NASA/MSFC diffusion predictions for the deployment of NASA/LaRC monitoring sites. The joint solid rocket motor exhaust prediction (MSFC) and measurement (LaRC and KSC) program evolved in 1972 utilizing the Titan and Delta launches as a source for empirical information that can be employed to more accurately predict the environmental effects of planned Space Shuttle operations.

These data are archived both as an aid in postlaunch analysis and because they represent a unique set of atmospheric soundings with high temporal resolution. Included in the report are the synoptic charts, surface observations, rawinsonde soundings, and satellite imagery. There is no attempt to analyze any of the data.

II. DATA

The data are listed in Appendices A through D; page numbers for specific data are given in the Table of Contents. The dates, times, and sources of the data are listed in Table 1.

The synoptic charts are from the series published weekly by the National Oceanographic and Atmospheric Administration (NOAA). The surface data are from the Cape Canaveral Air Force Station (location shown as KSC meteorological station in Figure 1).

TABLE 1. METEOROLOGICAL DATA SUMMARY FOR TITAN III C
(AF-777) LAUNCH ON 13 DECEMBER 1973 AT 1857 EST (2357Z)

Data Type	Date (Dec 1973)	Time		Source
		EST	Relative ^a	
Synoptic Charts ^b	12	0700	T-35 hr 57 min	NOAA
	13	0700	T-11 hr 57 min	NOAA
	14	0700	T+12 hr 3 min	NOAA
Surface Observations ^c	13, 14	0058 13 Dec to 2358 14 Dec	T-17 hr 59 min to T+29 hr 1 min	USAF
Rawinsonde	13	0015	T-18 hr 42 min	USAF
	13	0457	T-14 hr	USAF
	13	0757	T-11 hr	USAF
	13	1057	T- 8 hr	USAF
	13	1357	T- 5 hr	USAF
	13	1557	T- 3 hr	USAF
	13	1901	T+ 4 min	USAF
	14	0015	T+ 5 hr 18 min	USAF
	14	0615	T 11 hr 18 min	USAF
	14	1215	T+17 hr 18 min	USAF
Satellite Imagery (IR)	12	2120	T-21 hr 37 min	NOAA

^aRelative to launch time; for example, 1859 EST = T+2 min.

^bCharts for surface and 500 mb; also included are precipitation and maximum and minimum temperatures for the preceding 24-hr period.

^cLocation of the base station for upper air and surface observations is illustrated in Figure 1.

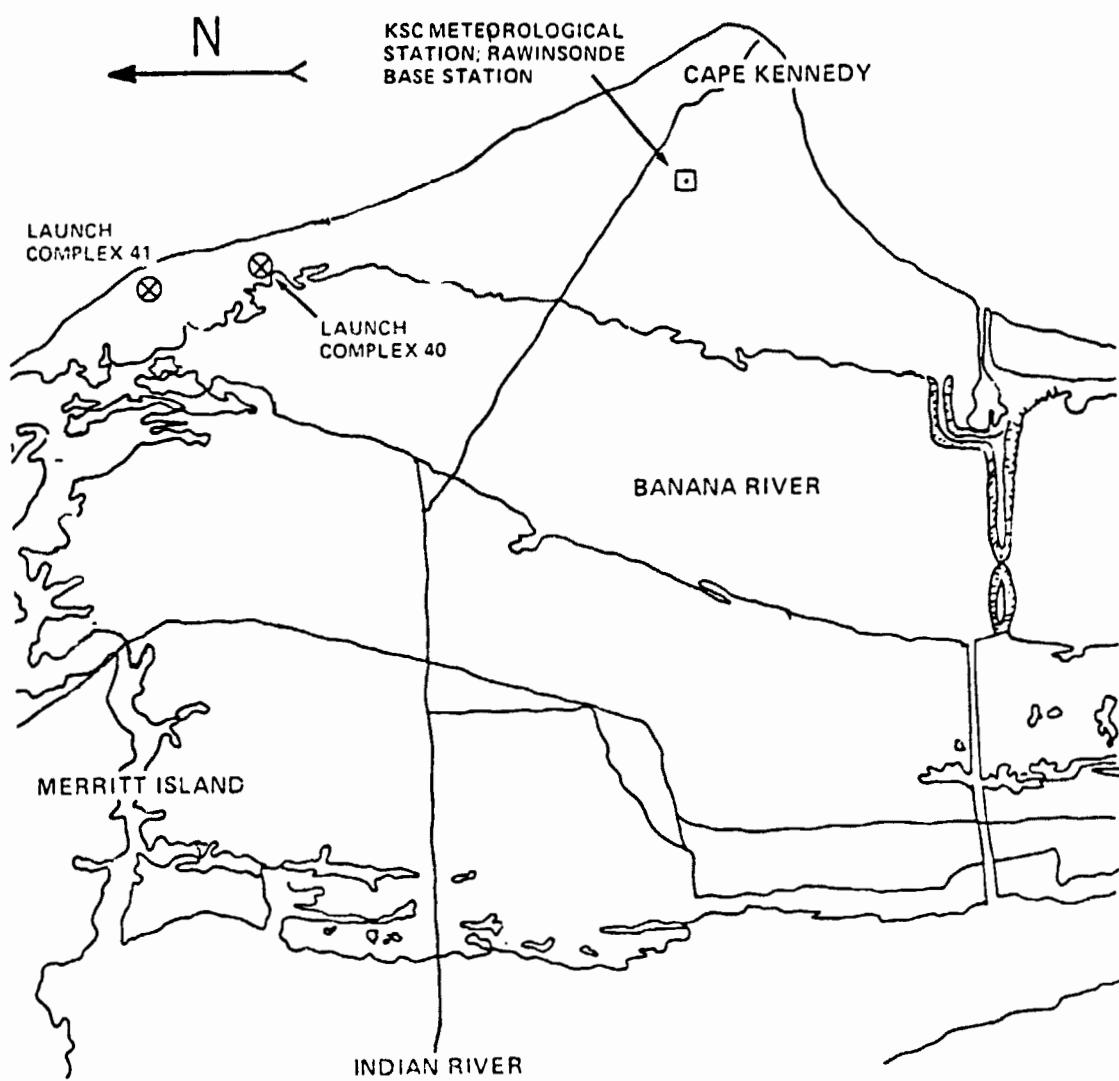


Figure 1. Location of KSC meteorological station for surface and upper air observations.

The rawinsonde runs were made with an AMQ-9 radiosonde (Fig. 2) using the GMD-4 rather than the NOAA J005B radiosonde system. The temperature and humidity sensor data are transmitted ten times per minute in the AMQ-9 by a clock-actuated switch rather than the aneroid barometer switch used in the NOAA radiosonde. Both systems measure azimuth and elevation with the directional receiver in the GMD. A transponder in the AMQ-9 is used to obtain the slant range to the radiosonde, enabling the calculation of altitude. The pressure is then calculated according to the hypsometric equation. The equations used in the computer program to calculate various thermodynamic quantities from the basic altitude, temperature, and relative humidity data are given in Appendix E.

Since it is envisioned that use of the rawinsonde data will be restricted to studies of the stabilized Space Shuttle rocket booster cloud, an altitude limit of 6.8 km (20 000 ft) was chosen; all data beyond that altitude are not included in this report. The excluded data are archived at MSFC and are available.

The data contained in this report cover a time period that is sufficient for most anticipated meteorological analyses. The chronology of the data relative to the time of launch is given in Figure 3. In most studies, data within 1.5 hours of launch time are sufficient. To facilitate retrieval of these data, an index is provided in Table 2 which gives the page number of data obtained within 1.5 hours of launch.

III. LAUNCH CONDITIONS

At launch, the KSC meteorological station reported scattered clouds, a visibility of 10 miles, and a surface wind from the south-southwest at 7 knots. The winds aloft, measured with a rawinsonde released at T - 4 minutes, were from the southwest at altitudes up to 1.83 km (6000 ft). The exhaust cloud, which was observed to stabilize at an altitude of 1.4 km (4600 ft), had a trajectory which paralleled the observed wind direction.

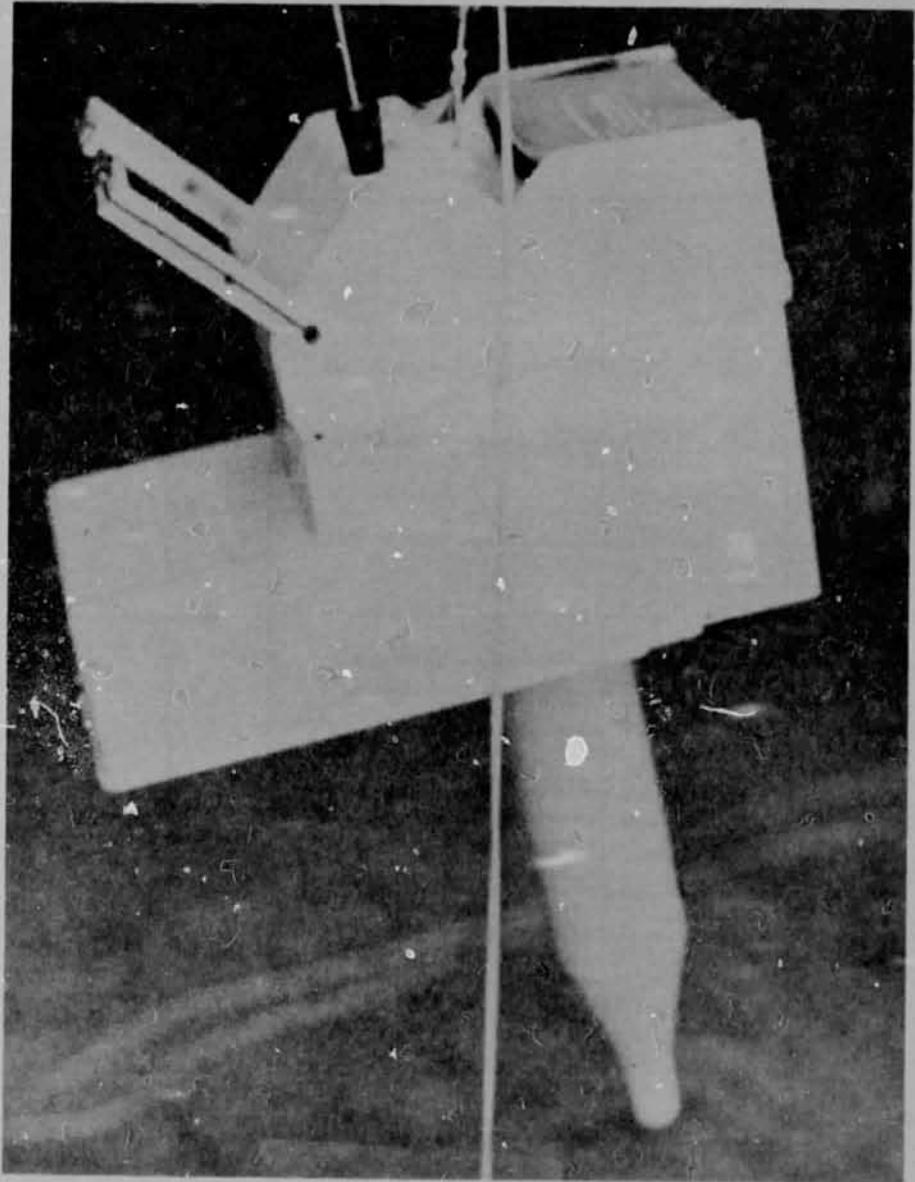


Figure 2. AMQ-9 radiosonde.

(11) EST - EASTERN STANDARD TIME
EST - GREENWICH MEAN TIME (Z) - 5 HOURS

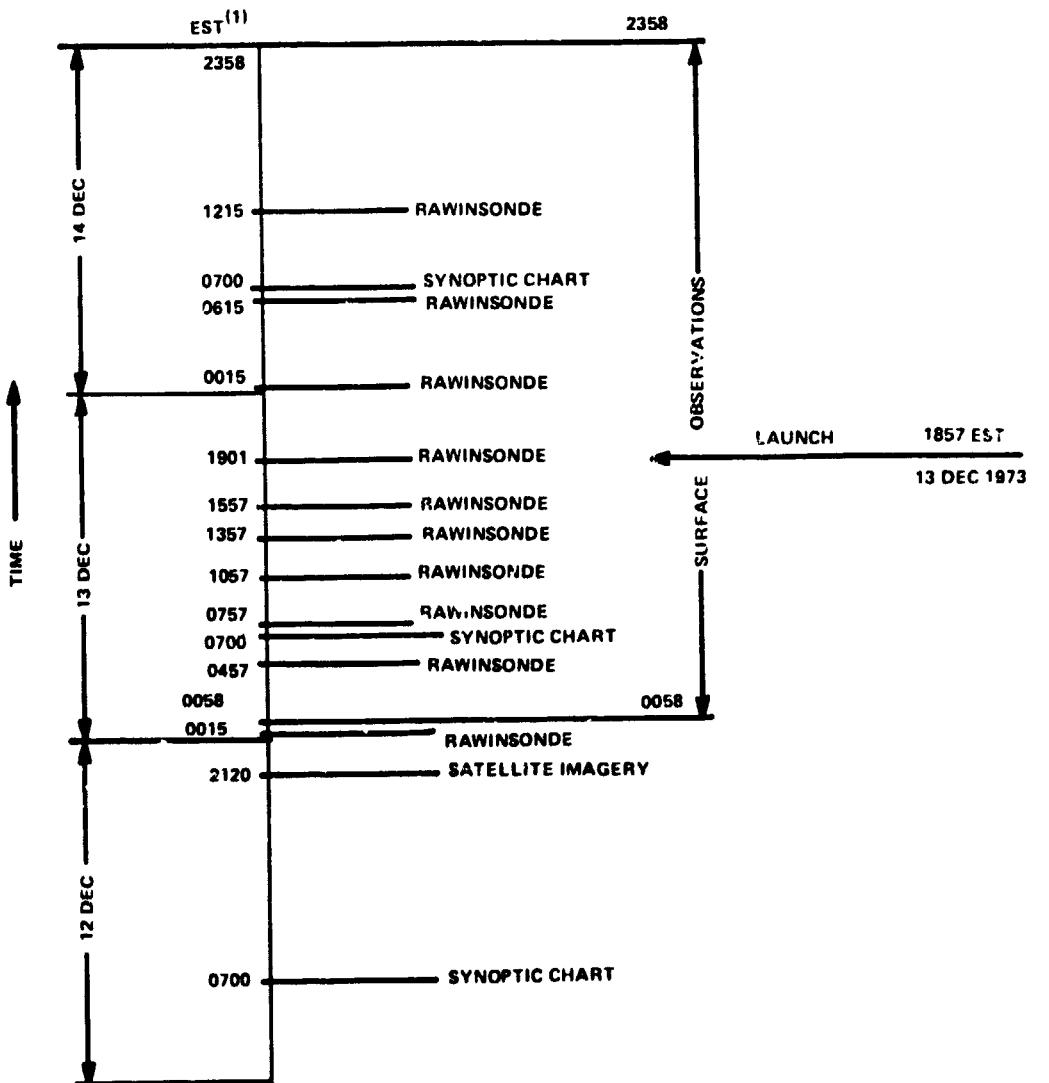


Figure 3. Data chronology.

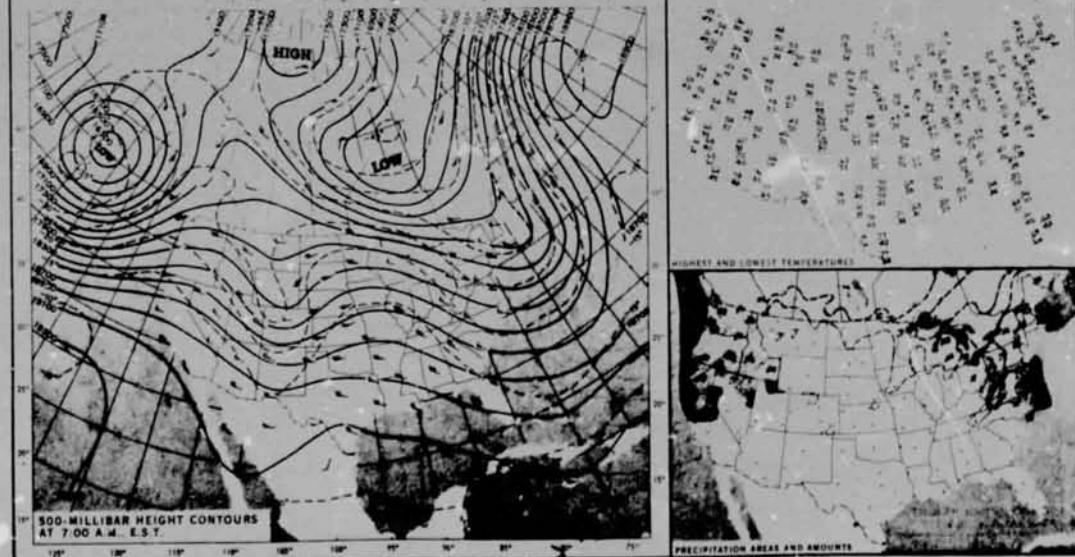
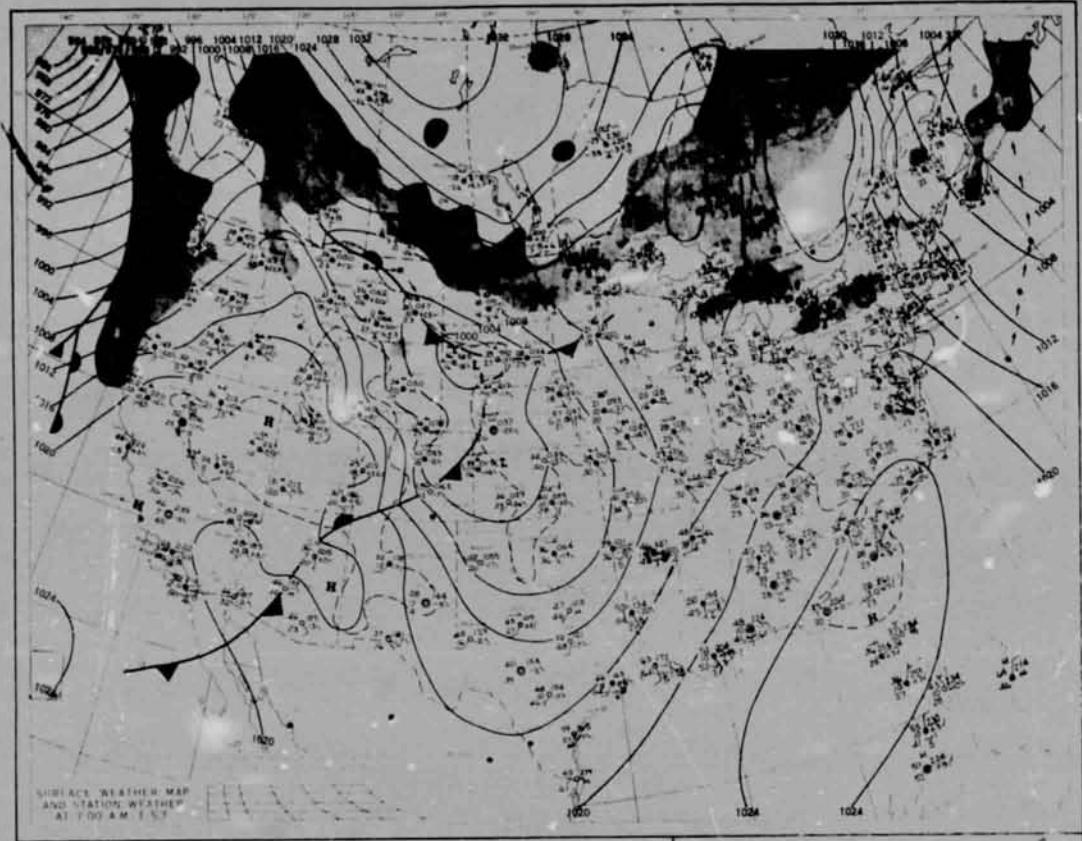
**TABLE 2. METEOROLOGICAL DATA OBTAINED WITHIN 1.5 HOURS
OF T-0 (1857 EST, 13 DEC 1973)**

<u>Time</u>		<u>Data Type</u>	<u>Page</u>
T-	59 min	Surface Observation	13
T-0		Surface Observation	13
T +	4 min	Rawinsonde	24
T + 1 hr		Surface Observation	13

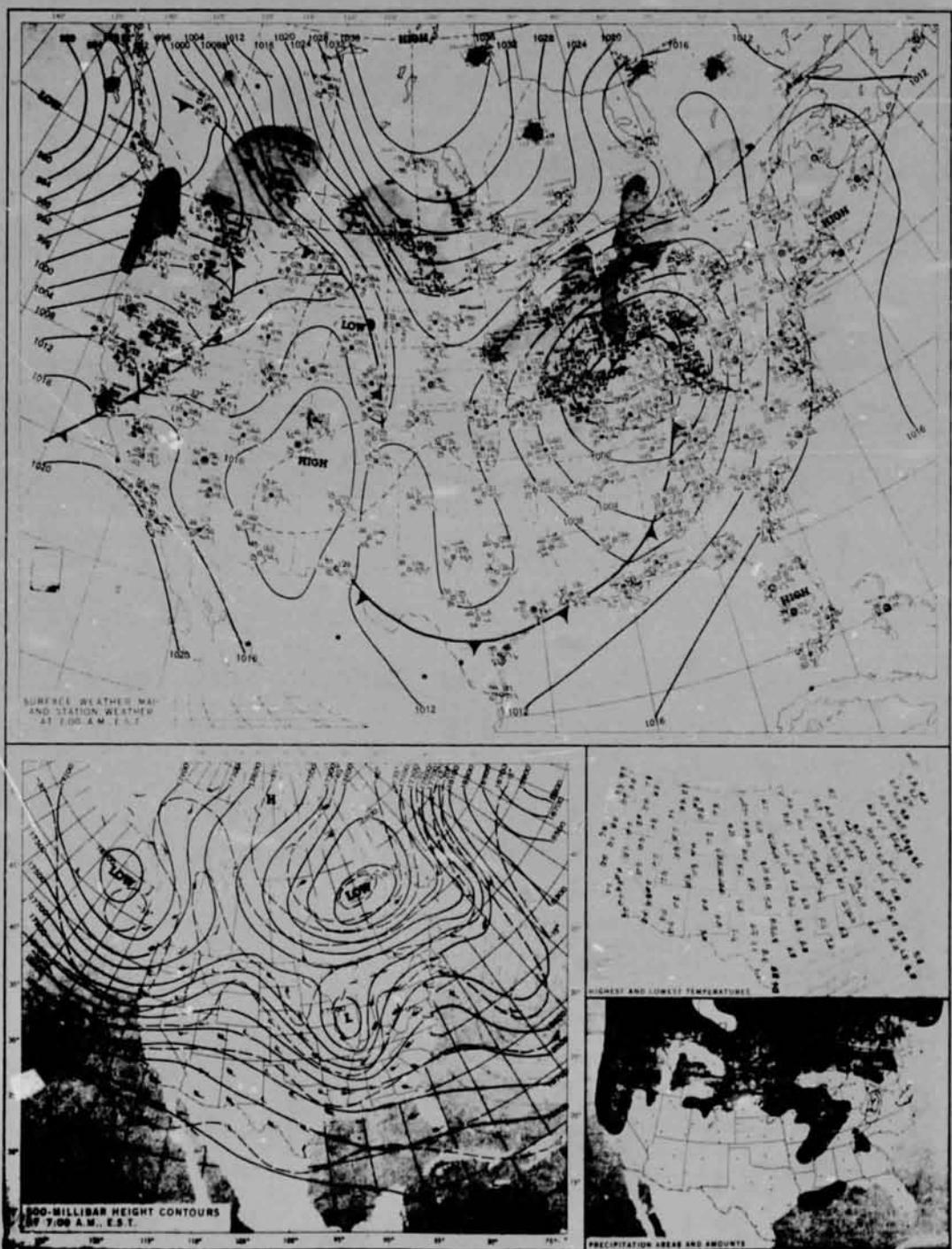
APPENDIX A

**SYNOPTIC CHARTS
(1973)**

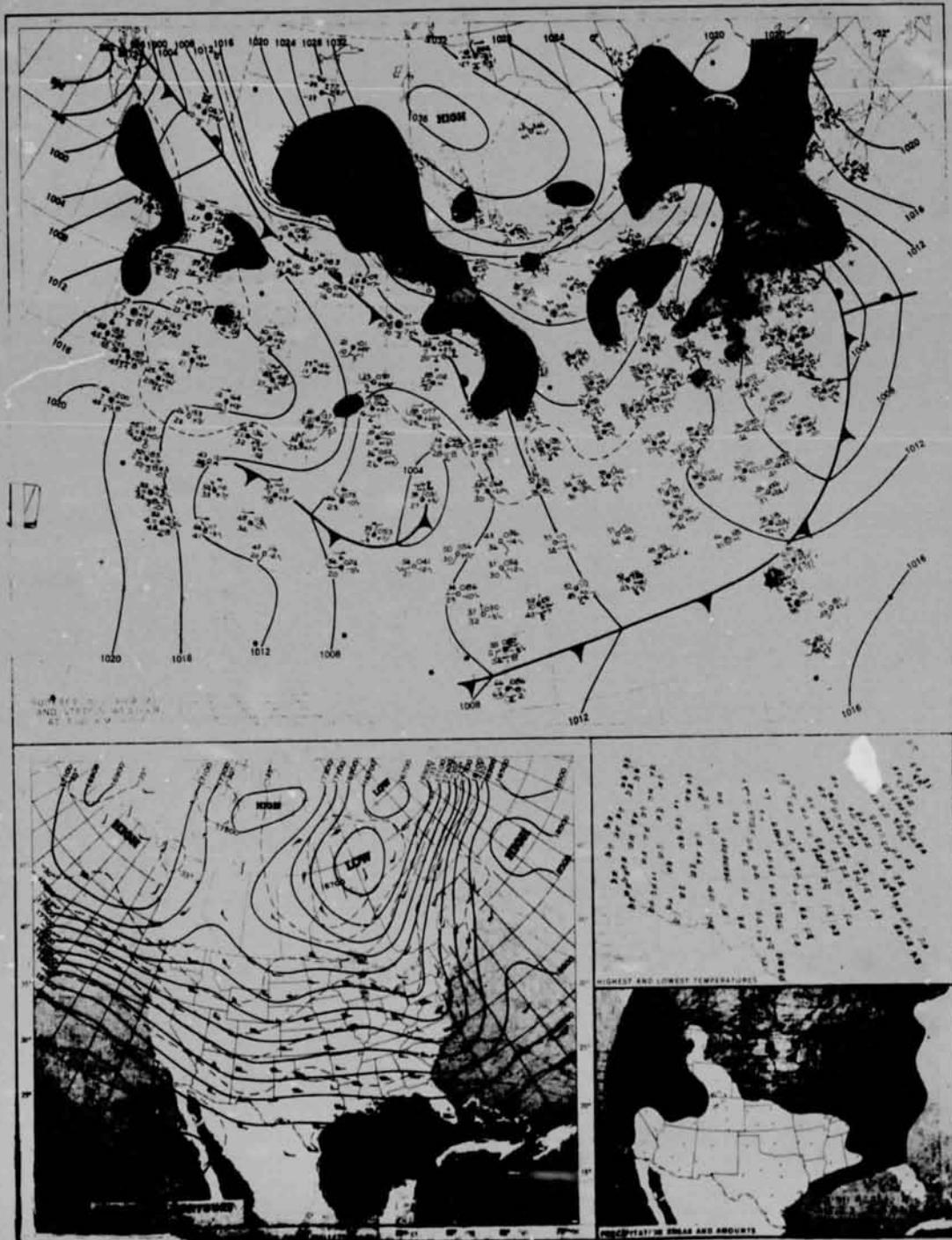
WEDNESDAY, DECEMBER 12, 1973



THURSDAY, DECEMBER 13, 1973



FRIDAY, DECEMBER 14, 1973



APPENDIX B

SURFACE OBSERVATIONS
(KSC, 1973)

APPENDIX C

RAWINSONDE DATA
(1973)

HAWAII-SOLOME RUN AN/DMU-4
CAMP KENNEDY AFS, FLORIDA
0915Z 15 DEC 1973
ASCR 47 MAR 0705

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DELT PT DEG C	PRESS HRS	RH PERCENT	AIR HUM G/RH	DENSITY G/RH	I/R N	VS KTS	SWELL	
											/SEC	DEG
10	205	4	1.0	-0.1	1047.00	94	4.78	1200.66	318	645	0	0
1000	160	4	12.6	4.2	711.98	57	6.27	1193.54	304	658	.012	138
2000	175	9	12.7	-3.5	647.01	38	5.62	1152.00	279	659	.008	163
3000	189	12	11.5	.2	513.42	46	4.74	1114.97	278	657	.007	222
4000	214	12	6.4	-7.7	480.42	29	2.63	1043.99	256	655	.011	294
5000	235	11	7.9	-8.4	448.59	31	2.52	1050.28	250	653	.006	334
6000	255	11	7.2	-11.3	417.61	25	2.00	1019.09	230	652	.007	342
7000	262	11	5.9	-13.7	386.34	23	1.65	982.69	220	651	.003	347
8000	271	12	5.2	-15.7	359.25	20	1.41	949.40	220	650	.002	322
9000	273	12	4.7	-16.1	331.45	20	1.35	916.19	213	649	.002	333
10000	281	14	3.1	-20.1	274.57	16	.97	688.04	204	647	.003	319
11000	280	17	1.2	-21.1	218.50	17	.40	640.94	198	645	.006	277
12000	278	21	-5.3	-21.9	183.49	18	.84	633.58	191	644	.007	269
13000	277	25	-2.1	-23.0	156.00	18	.76	8.7.87	185	641	.007	271
14000	277	27	-3.5	-24.1	105.13	18	.75	701.42	179	640	.004	282
15000	279	28	-5.2	-24.7	58.23	20	.67	756.62	173	638	.002	320
16000	283	29	-6.4	-25.3	56.00	21	.63	771.17	167	636	.004	1
17000	260	28	-6.1	-26.4	228.06	21	.54	777.78	161	634	.002	37
18000	285	29	-6.3	-28.5	217.44	19	.48	643.70	155	633	.002	238
19000	285	32	-11.1	-29.6	457.71	20	.43	651.72	150	631	.005	283
20000	287	34	-11.5	-28.7	478.58	27	.49	641.77	146	628	.004	317

HADATRY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DELT PT DEG C	PRES HRS	RH
196	40	2	12.7	5.3	5000	01
1410	175	9	12.7	-2.8	950	35
3394	205	14	14.3	-0.9	900	47
4447	234	11	7.7	-8.2	650	31
5583	262	11	6.5	-12.6	800	24
6514	276	12	5.1	-16.1	750	24
11553	281	14	2.7	-20.3	700	16
14407	278	22	-0.6	-22.1	650	16
14514	278	28	-4.1	-24.6	600	16
16430	285	29	-7.7	-26.0	550	20
18651	284	31	-10.0	-29.8	500	19

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DELT PT DEG C	PRES HRS	I/R
10	285	4	1.0	-0.1	1017.80	318
429	18	4	12.7	5.9	1009.80	316
4444	170	10	12.7	-4.2	944.12	277
3171	203	14	17.0	2.9	907.58	283
3816	217	13	6.6	-7.6	888.49	256
5531	275	12	4.7	-16.1	730.04	212
5592	281	14	3.1	-20.1	704.76	204
14295	278	20	-4.6	-25.5	591.41	175
18681	284	31	-10.0	-29.8	580.83	191

MANI SURVEY RPT A1/GMD-4
CAPE KENNEDY AFS, FLORIDA
0957Z 18 DEC 1973
ASCE-T 46A 0796

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH PERCENT	AB NUM 6/13	DENSITY 0/M3	1/R N	VS KTS	SHEAR	
											/SEC	DEG
16	270	4	1.6	1.1	1020.20	97	5.23	1239.65	320	646	0	0
2100	243	12	12.7	-5.2	760.25	28	3.17	1193.26	295	659	.013	226
2200	226	19	12.4	-6.7	745.00	22	2.41	1192.26	271	658	.012	217
3300	222	21	5.4	5.7	711.72	77	7.1	1119.77	293	655	.006	183
4600	224	20	7.3	6.9	678.02	65	6.72	1087.48	284	652	.002	4
5620	230	16	5.5	99.9	646.83	999	99.99	1047.32	245	650	.010	7
6400	247	13	4.7	-13.7	615.05	25	1.05	1021.92	238	644	.006	16
7600	246	16	6.1	-16.8	756.03	17	1.27	940.06	226	631	.003	245
8600	248	20	3.9	-14.3	757.24	25	1.60	941.25	222	649	.006	253
9400	247	20	2.9	-20.2	729.35	18	1.06	919.76	212	647	0	109
10000	252	21	2.1	-26.9	722.91	16	.97	880.60	204	646	.003	319
11100	258	22	-.5	-21.9	666.29	16	.04	843.65	198	643	.004	316
12400	261	24	2.3	-23.3	650.06	16	.74	838.83	191	641	.003	293
13600	262	26	3.7	-25.4	626.95	17	.62	809.69	184	639	.004	281
14600	263	26	5.1	-26.7	602.73	17	.55	783.47	178	638	.001	10
15600	266	28	6.2	-27.6	579.81	16	.51	756.49	172	636	.004	293
16600	271	30	7.1	-29.0	557.67	15	.45	730.04	166	635	.002	323
17700	270	31	9.5	-29.0	536.27	19	.45	7-8.37	161	633	.003	341
18600	271	32	11.7	-30.3	515.46	26	.41	686.95	156	631	.005	295
19700	269	32	13	-32.6	465.37	16	.34	663.35	150	628	.010	173
21000	257	32	15.5	-34.1	479.92	16	.29	643.24	145	625	.003	173

AERODYNAMIC LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS '65	RH PERCENT
556	253	8	12.1	1.9	4000	96
1369	229	18	12.5	-8.0	950	23
3346	221	21	5.7	5.5	900	86
4996	235	16	5.8	99.9	850	99
5515	247	14	5.8	-17.1	800	17
7446	246	21	3.4	-12.1	750	31
11172	253	21	1.0	-21.0	700	16
12415	261	24	-2.4	-23.4	650	12
14488	264	26	-5.3	-27.0	600	16
16519	274	30	-7.4	-28.9	550	16
18723	268	32	-13.1	-32.3	500	16

SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	1/R N
16	270	4	1.4	1.1	1010.54	360
405	255	8	12.1	2.9	1001.40	307
776	249	11	12.5	-4.1	988.46	266
1198	238	14	12.1	-6.1	973.54	202
1587	232	16	12.1	-6.9	959.89	177
2426	228	19	12.4	-6.8	944.09	171
2745	222	21	6.5	.7	913.55	146
3513	220	19	7.1	4.4	900.72	201
4658	232	18	6.1	99.9	857.69	238
5146	238	19	5.4	-10.0	842.25	246
6084	247	13	4.4	-13.6	813.30	266
7756	246	16	6.1	-16.8	787.30	227
7720	247	20	2.8	-12.2	751.06	216
8117	247	20	3.5	-23.6	726.15	205
10050	252	21	2.1	-20.9	701.10	203
12759	250	22	1.3	-22.3	687.72	201
13694	263	26	-9.7	-26.5	667.41	176
14291	273	30	-7.2	-29.0	591.37	160
16721	270	31	-8.7	-28.4	542.10	167
16487	268	32	-12.6	-31.0	509.85	150
16994	260	32	-12.9	-32.9	499.47	156
17309	258	32	-14.0	-34.6	487.73	157
17030	257	32	-15.1	-33.6	479.18	149

HAWAII SONDE RUN AV/6MD-4
CAMP KENNEDY AFS, FLORIDA
12974 13 DEC 1973
ASSENT NUR 6707

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS Hg	RH	AV HUM G/M3	EMISITV G/M3	I/H N	VS KTS	SHEAR /SEC DEG	
											1/H N	VS KTS
16	280	4	2.1	0	1036.90	87	4.62	1224.53	317	646	0	0
1600	268	17	12.6	-10.2	729.77	26	2.14	1195.00	970	638	.013	268
2400	268	11	12.4	-10.0	745.01	23	2.17	1191.92	270	639	.007	168
3200	228	19	11.3	-9.7	911.95	23	2.24	1119.50	263	636	.006	187
4000	218	19	6.6	-12.6	979.08	26	1.75	1055.21	253	634	.008	186
5000	216	19	6.3	-12.0	947.10	26	1.91	1054.99	247	631	.004	126
6000	209	17	4.2	-14.9	816.40	24	1.59	1074.22	230	649	.003	42
7000	219	18	6.2	-20.6	756.20	12	.99	970.96	224	651	.005	286
8000	234	22	4.5	-19.3	757.23	16	1.03	949.91	218	649	.018	291
9000	243	24	2.9	99.9	/29.67	99.99	99.99	970.10	211	647	.006	204
10000	249	27	1.6	-24.9	702.09	12	.04	890.64	202	646	.006	294
11000	259	26	1	-27.0	676.08	11	.53	842.39	196	644	.023	312
12000	253	26	-1.9	-28.6	691.67	11	.47	876.14	189	642	0	283
13000	259	26	-1.6	-31.0	626.76	11	.37	879.42	183	640	.003	199
14000	251	29	-4.0	-32.1	603.04	10	.33	782.64	177	634	.002	298
15000	256	30	-5.6	-33.7	580.13	9	.28	745.02	170	637	.005	313
16000	262	32	-7.2	-33.9	558.42	10	.28	740.86	165	635	.006	317
17000	268	32	-6.3	-33.7	526.90	12	.29	748.32	160	633	.006	5
18000	271	32	-11.5	-35.7	515.03	11	.24	646.76	155	632	.003	344
19000	272	36	-12.9	-37.0	495.00	12	.21	656.06	150	627	.006	270
20000	268	38	-16.4	-38.0	476.10	12	.18	649.98	145	624	.006	211

*ADDITIONAL LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS Hg	RH	ADDITIONAL LEVELS	
							DIR DEG	SPEED KTS
162	273	11	12.2	-6.4	4000	28		
1676	249	11	12.9	-10.9	950	16		
3355	224	17	6.8	-9.8	900	24		
4912	211	19	6.5	-12.9	650	24		
6525	210	17	4.2	-16.8	680	20		
7654	237	23	4.	-20.2	750	15		
10462	250	27	1.5	-25.2	700	14		
12427	253	28	-6.1	-28.5	650	11		
14401	252	29	-5.9	-32.2	600	10		
14335	264	32	-7.9	-33.5	550	11		
18740	271	35	-13.9	-36.8	500	14		

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS Hg	RH	SIGNIFICANT LEVELS	
							DIR DEG	SPEED KTS
16	280	4	2.1	0	1036.90	33		
697	282	6	4.4	-13.2	1000.21	24		
477	273	11	12.8	-6.0	999.57	26		
1743	253	11	12.2	-11.9	954.06	470		
6022	209	17	6.2	-15.0	612.54	23		
7902	213	17	4.1	-16.5	801.01	252		
8773	219	18	4.2	-26.8	787.00	224		
7242	230	23	4.1	-27.0	750.69	216		
7728	241	24	2.6	-11.3	737.17	216		
7610	245	25	2.4	99.9	723.03	204		
7650	248	26	2.1	-24.2	712.02	209		
13236	249	28	-3.9	-32.6	621.40	181		
12639	257	31	-9.5	-33.7	574.87	188		
12293	260	32	-6.2	-35.5	560.94	188		
14775	268	38	-15.7	-38.3	481.49	140		

NAME: SUMME RUN AN/GMC-4
CAFE MCKEELEY AFR, FL041DA
19976 18 DEC 1973
ASSENT NO. 6700

ALTITUDE FEET	DIN DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS HRS	RH PER	AB HUM G/H3	TENSITY H/H3	I/H N	VS KTS	SHEAR /SEC DEG	
											G/H3	H/H3
1000	230	7	16.2	-3.6	1010.00	29	3.47	221.82	293	663	0	0
1000	244	10	17.4	-7.2	911.17	23	2.71	190.49	282	661	.007	270
2000	231	13	17.5	-8.1	946.33	21	2.95	148.80	271	662	.010	269
3000	218	20	11.4	-9.5	912.25	24	4.27	115.92	243	657	.010	167
4000	219	29	9.2	-14.1	879.74	16	1.59	104.38	251	659	.008	242
5000	216	27	7.4	-12.4	847.69	23	1.66	105.1.83	246	652	.009	231
6000	209	26	5.3	-13.7	817.60	24	1.66	921.19	238	657	.006	208
7000	219	25	5.6	-16.0	787.09	16	1.15	93.08	220	650	.007	313
8000	237	25	5.2	-18.7	758.35	16	1.49	448.63	218	652	.013	273
9000	249	24	3.7	-21.6	730.97	19	.67	922.01	211	647	.008	346
10000	250	25	3.9	-21.4	713.44	17	.80	893.59	205	645	.004	308
11000	252	26	4.1	-23.7	677.67	19	.71	853.14	197	644	.004	317
12000	258	27	-1.6	-25.2	651.98	14	.63	835.99	190	642	.003	305
13000	263	30	-3.6	-27.4	627.42	14	.52	810.73	184	640	.006	303
14000	269	34	-5.0	-28.4	603.06	14	.47	793.86	178	638	.008	311
15000	274	34	-5.9	-29.1	580.74	14	.44	776.63	171	637	.005	347
16000	275	32	-7.9	-30.5	555.24	14	.39	733.31	164	634	.003	75
17000	277	32	-5.7	-33.7	527.06	15	.39	710.02	160	632	.022	13
18000	278	31	-12.1	-33.2	510.44	15	.41	686.59	155	637	.003	213
19000	266	31	-14.4	-33.2	486.05	15	.25	647.63	150	627	.007	183
20000	262	32	-16.4	-36.8	476.47	15	.22	646.99	146	624	.006	193

ANALOGY LEVELS

ALTITUDE FEET	DIN DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	P-EBS HRS	RH PER
973	248	6	14.7	-4.8	4000	26
1090	232	15	13.7	-6.0	950	71
1374	216	22	11.6	-12.6	900	16
1424	216	27	7.5	-12.9	850	24
1552	213	25	4.8	-15.7	800	21
1682	241	24	4.3	-19.2	750	16
18110	251	25	4	-21.7	700	17
12055	258	26	-1.7	-25.4	650	14
14126	270	34	-9.1	-28.6	600	14
15358	272	32	-8.4	-31.0	550	14
16750	264	30	-13.0	-34.8	500	15

STANDARD LEVELS

ALTITUDE FEET	DIN DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	P-EBS HRS	I/H
10	236	7	16.2	-3.6	1010.00	292
1136	243	11	17.3	-7.6	970.34	606
1213	237	13	14.2	-7.1	933.14	276
2799	209	26	5.3	-13.6	617.15	238
6377	211	25	4.6	-14.2	602.59	235
1184	225	25	4.4	-18.1	770.01	622
1130	251	25	4.6	-21.5	700.70	294
12460	258	28	-2.1	-25.6	646.00	186
12169	260	29	-3.2	-26.4	637.78	198
14243	272	35	-5.6	-28.9	591.16	174
16557	279	33	-8.7	-31.2	544.34	182

RAINFALL RUN AN/GRD-4
CAPE KENNEDY AFB, FL041DA
18574 13 DEC 1973
ASPECT RDR 0700

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH PERCENT	ATM HPa	DENSITY g/m3	I/R %	VS FTS	SHEAR 1/4FC DEG
16	200	11	21.0	.5	1032.00	26	4.67	1196.98	294	668	0 0
1800	217	16	19.0	-4.4	977.98	24	3.25	1176.72	282	662	.011 240
2000	228	25	14.6	-10.4	943.94	20	2.91	1139.72	269	661	.016 230
3000	223	31	13.4	-10.6	909.97	18	2.14	1175.16	259	659	.009 229
4000	222	32	14.6	-10.7	877.98	16	1.26	1076.98	248	656	.004 200
5000	239	38	6.0	-17.7	845.86	12	1.16	1040.27	239	655	.000 342
6000	247	28	7.4	-21.0	815.99	11	.84	1011.74	231	653	.012 350
7000	250	25	9.6	-24.3	785.99	9	.66	981.37	223	650	.006 10
8000	253	24	8.4	-26.5	756.74	9	.94	952.95	216	648	.004 19
9000	251	26	3.4	-20.4	728.82	7	.46	917.86	207	646	.003 234
10000	--	251	30	-1.6	701.96	5	.44	899.88	201	644	.007 270
11000	252	30	-0.7	-30.2	675.77	3	.39	864.00	195	643	.001 270
12000	253	32	-2.9	-51.0	650.46	9	.34	830.24	189	642	.004 270
13000	255	35	-2.7	-32.6	625.95	8	.31	809.00	182	639	.008 320
14000	274	37	-8.6	-33.9	602.16	6	.29	776.12	175	640	.011 389
15000	274	38	-9.3	-34.1	579.37	5	.27	754.10	170	637	.005 347
16000	273	38	-7.3	-34.0	557.27	3	.23	738.20	164	635	.006 14
17000	282	39	-9.8	-37.3	535.95	8	.20	710.19	159	632	.004 337
18000	263	39	-8.7	-39.6	515.06	6	.16	688.19	154	629	.003 37
19000	274	34	-15.2	-40.5	484.97	9	.19	668.38	150	626	.012 150
20000	268	36	-18.1	-42.4	475.20	10	.12	649.87	149	622	.007 190

SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	I/R %
16	200	11	21.0	.5	1032.00	294
411	711	10	18.0	-1.5	1003.95	671
800	214	13	16.8	-3.1	989.93	280
2427	223	28	14.4	-17.6	929.03	258
2930	223	31	13.7	-8.7	914.27	261
3434	224	32	12.1	-19.5	900.33	251
5519	241	29	6.0	-20.9	829.88	244
2995	247	28	7.9	-21.9	815.59	231
6877	290	6.0	-24.2	786.19	223	
7312	250	24	4.9	-24.6	776.91	221
8597	254	24	2.4	-27.0	739.95	211
9068	252	26	3.6	-28.5	726.97	207
12458	258	34	-3.9	-32.4	639.85	166
14046	270	37	-3.5	-33.5	601.13	175
17186	282	39	-10.0	-37.9	531.94	156
17563	283	39	-11.3	-38.4	524.07	156
18393	281	37	-12.4	-39.7	507.06	153
18554	270	35	-14.4	-40.4	501.78	151
18982	270	34	-16.0	-41.7	485.89	148
19700	269	35	-18.0	-42.3	477.03	146

"A" DYNAMIC LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH
976	212	11	18.1	-2.4	1000.0	23
1035	222	24	15.7	-6.5	950	47
1200	32	12.1	-18.4	900	16	
4559	234	31	11.1	-17.3	890	13
6508	254	27	4.9	-23.6	880	18
9224	252	23	3.1	-26.8	790	9
10953	251	30	1.4	-20.1	780	6
11793	253	32	-2.0	-31.0	650	9
14065	270	30	-2.6	-33.6	600	8
16400	280	38	-8.2	-36.4	550	8
18700	277	35	-14.0	-40.0	500	9

RAM/SONNE RUN AH/QMD-4
CAPE KENNEDY AFS, FLORIDA
20574 13 DEC 1973
ASCENT HHR 0000

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH PCT	AB. VIT H/H	COND H/H	T/H	VIS M	SHEAR /SEC DEG
10	100	12	20.0	0.0	1010.00	40	0.90	1190.00	300	667	0 0
1000	202	21	17.7	-1.1	976.50	29	1.20	1158.03	286	664	.016 217
2000	205	24	14.6	-3.1	941.70	20	3.60	1130.07	276	661	.007 242
3000	220	25	12.3	-5.3	908.20	26	5.07	1106.90	265	658	.009 290
4000	232	22	11.0	-15.7	875.70	14	1.37	1073.50	240	655	.010 349
5000	242	16	11.4	-18.7	844.20	11	1.00	1036.73	230	650	.012 29
6000	250	14	11.4	-9.0	813.00	27	2.0	1005.00	210	654	.007 10
7000	261	17	6.4	-11.3	783.30	27	1.89	973.22	200	651	.006 209
8000	268	20	4.9	-19.8	755.60	19	1.29	945.99	210	650	.009 270
9000	267	20	4.8	-28.4	728.00	7	.49	912.36	200	649	.010 279
10000	266	22	2.9	-31.9	701.40	6	.34	886.04	200	647	.006 260
11000	266	33	-2.2	-33.5	675.40	6	.29	840.24	193	644	.002 276
12000	271	34	-1.4	-32.3	649.70	6	.12	834.47	186	642	.005 342
13000	277	36	-2.2	-36.1	625.50	6	.22	807.17	181	640	.007 338
14000	280	36	-4.1	-37.0	601.00	6	.20	779.38	175	639	.009 310
15000	277	39	-4.5	-38.2	579.00	6	.18	756.43	170	636	.004 226
16000	275	41	-4.5	-39.5	559.00	6	.16	732.68	164	634	.004 230
17000	273	43	-16.5	-39.5	535.30	7	.14	719.89	159	631	.004 220
18000	268	43	-23.1	-43.1	514.20	7	.14	699.19	154	629	.005 279
19000	267	43	-18.5	-43.0	494.20	6	.11	689.56	150	629	.004 186
20000	269	43	-18.5	-44.5	474.94	6	.10	649.20	145	622	.003 8

Mandatory Levels

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	RH PCT
217	197	19	16.4	4.0	4000	38
1754	206	24	15.0	-4.7	390	29
3445	224	29	11.8	-6.2	900	26
5007	240	17	11.5	-19.7	850	10
6455	250	15	7.4	-12.6	800	22
8188	265	24	5.0	-17.1	750	18
10027	266	32	2.4	-31.6	700	6
11473	271	34	-1.0	-32.3	650	6
14051	280	36	-4.3	-37.2	600	6
16470	274	42	-5.2	-39.8	550	6
18071	267	43	-15.4	-42.6	500	6

Significant Levels

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	I/H
10	100	12	20.0	0.0	1010.00	300
493	199	17	16.0	4.1	975.00	300
682	203	20	17.4	-1.1	900.21	207
1329	203	23	16.6	-1.3	904.03	203
1731	206	24	19.0	-8.7	950.00	270
3254	227	24	11.6	-7.0	894.00	200
3782	232	22	11.4	-15.6	870.20	240
5450	240	14	11.4	-15.4	830.32	237
7714	251	14	5.2	-9.9	822.51	244
7704	263	20	5.6	-12.6	764.70	246
8936	267	20	4.9	-28.4	725.76	207
12768	275	35	-3.2	-35.3	631.09	183
23182	278	36	-3.3	-36.7	621.12	180
14041	280	38	-4.2	-37.2	603.91	179
15622	268	43	-13.4	-41.9	585.97	153
14964	267	43	-15.1	-42.4	503.01	192

HAWINGER RUN 44/GRN-4
CAPE KENNEDY AFB, FLORIDA
0901Z 14 DEC 1973
ASSENT NR 6601

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS MB	RH PCT	AH MM	PRECIPIT MM/H	T/R %	VS KTS	SHEAR /SEC DEG	
											V	W
10	210	7	19.3	6.0	1011.90	97	7.41	1217.12	316	662	0	0
1600	221	25	19.7	4.3	976.72	38	6.14	1141.90	296	666	.031	.229
2600	231	28	16.6	4.3	942.50	46	6.21	1171.91	290	662	.009	.298
3006	241	26	13.1	9.0	909.60	50	6.59	1192.97	286	659	.000	.499
4000	244	27	10.8	9.1	876.70	69	6.69	1072.89	289	656	.003	.398
5000	243	18	6.2	-4.7	845.41	39	5.39	1048.67	293	655	.015	.21
6000	252	14	6.0	-8.3	814.75	39	5.42	1014.38	245	654	.009	.36
7600	270	11	7.8	-3.7	789.40	66	4.59	973.94	930	659	.000	.17
8000	293	15	3.2	-3.7	756.72	53	3.61	944.74	233	652	.000	.333
9000	291	19	2.7	-0.7	728.90	78	4.59	917.73	233	647	.007	.34
10000	290	10	-.4	-1.6	722.02	68	4.41	891.34	226	644	.003	.191
11000	289	19	-0.1	-11.0	675.92	43	2.09	840.99	225	644	.008	.214
12000	279	22	-.4	-24.2	650.70	15	1.60	831.90	190	643	.007	.290
13000	276	28	-3.0	-11.1	626.40	54	2.11	806.27	193	640	.010	.263
14000	278	33	-4.2	-24.8	602.66	19	1.79	790.17	178	639	.009	.296
15000	280	36	-8.6	-33.0	579.80	0	1.00	754.00	170	637	.008	.340
16000	280	36	-7.4	-32.3	557.07	12	1.34	730.73	165	639	0	.199
17000	277	36	-0.7	-27.1	536.23	23	1.94	710.00	162	632	.003	.107
18000	275	37	-1.3	-20.5	515.44	29	1.50	686.89	157	629	.003	.230
19000	277	61	-1.7	-23.4	493.23	51	1.74	660.84	154	629	.003	.293
20000	270	47	-16.2	-29.9	475.30	58	1.69	640.41	146	624	.003	.273
FADATCNY LEVELS												

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS MB	RH PCT	AH MM	PRECIPIT MM/H	T/R %	VS KTS	SHEAR /SEC DEG	
											V	W
330	210	17	19.3	-0.4	1000.00	33						
1776	220	20	16.6	4.3	956.49	49						
3276	242	28	12.6	3.1	900.00	60						
4838	243	21	8.2	1.3	850.00	59						
626	253	12	8.2	-4.4	880.00	41						
6225	294	16	4.8	-2.1	750.00	61						
16057	290	18	-.4	-1.8	780.00	85						
12004	279	22	-0.0	-24.8	696.00	39						
14059	276	34	-4.4	-25.2	680.00	18						
15510	279	36	-0.1	-20.3	590.00	16						
16/10	270	40	-12.0	-23.6	580.00	47						
SIGNIFICANT LEVELS												

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS MB	RH PCT	AH MM	PRECIPIT MM/H	T/R %	VS KTS	SHEAR /SEC DEG	
											V	W
10	210	7	19.3	6.0	1011.90	316						
344	217	24	19.7	-5.0	994.62	281						
559	220	25	16.6	4.4	970.19	296						
4900	237	20	14.4	9.0	924.81	280						
4772	240	28	12.1	9.0	910.11	286						
3410	243	28	12.4	9.2	899.81	284						
3881	244	27	12.0	9.3	881.29	282						
4652	246	9.0	4.8	4.8	874.03	276						
4940	244	25	8.3	4.5	850.46	276						
4770	243	23	7.7	4.1	854.20	274						
5013	243	18	5.3	-5.2	844.80	291						
5436	244	16	6.0	-7.7	831.85	284						
6590	290	10	3.0	-1.5	737.91	243						
7188	293	19	2.5	-0.5	720.68	243						
7719	291	18	-.4	-1.3	704.17	237						
11091	288	18	-.2	-2.8	691.71	231						
11090	289	19	-.1	-11.0	670.99	209						
11092	282	20	-.1	-0.0	665.67	209						
11091	279	22	-.3	-24.3	659.41	191						
12093	238	23	9.7	-24.0	641.00	180						
14093	270	26	-2.0	-14.7	627.79	196						
13118	270	26	7.3	-10.1	629.88	196						
13137	277	32	2.3	-7.1	610.23	183						
14781	286	35	9.0	-34.3	584.73	171						
16422	279	36	7.7	-30.3	592.09	166						
17780	279	36	71.6	-29.0	510.99	160						
18410	279	36	73.1	-27.2	511.84	160						
24 18078	276	39	74.7	-23.7	511.78	160						

NAME-SONJE RUN AN/AGM-4
CAPE CANAVERAL AFS, FLORIDA
0515Z 19 DEC 1973
ASCC-T TBR U802

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS HRS	RH PERC	AH MUN G/M3	E-SITY G/M3	I/R N	VS KTS	SHEAR /SEC DEG	
											W	E
16	220	13	15.5	10.7	1011.90	73	9.65	+215.37	329	662	0	0
1400	239	32	15.9	10.9	976.08	73	9.70	+171.63	320	662	.034	251
2100	247	31	15.4	9.6	942.22	70	9.24	+132.31	308	662	.008	347
3000	259	29	15.1	3.4	919.31	46	5.91	+109.48	280	661	.007	7
4000	260	27	13.6	4.1	977.15	93	6.18	+1042.09	274	663	.006	25
5000	260	26	11.8	4.3	945.91	64	6.35	+1033.86	269	657	.004	24
6000	260	25	9.1	3.7	915.55	70	6.15	+103.43	262	654	.003	31
7000	260	24	6.1	1.4	786.00	72	5.25	+977.67	251	651	.002	69
7400	260	23	3.6	1.1	757.27	63	5.14	+949.98	244	648	.001	164
8000	264	4	1.6	-1.7	729.37	79	4.29	+922.24	233	646	.002	215
11400	263	6		-2.7	712.32	52	3.99	+893.31	225	644	.003	246
11500	264	20		-10.9	676.15	56	2.51	+842.18	208	643	.004	275
12000	265	29		-18.4	650.96	24	1.14	+829.63	192	644	.001	348
13300	267	30	-2.3	-17.4	626.01	36	1.24	+815.13	187	641	.002	349
14000	270	32	-5.1	-13.1	602.97	55	1.83	+792.41	186	638	.004	302
15000	272	45	-7.2	-14.0	580.01	94	1.59	+758.86	179	635	.005	343
16000	275	37	-8.7	-15.9	557.78	56	1.45	+734.00	173	633	.005	311
17000	277	36	-11.6	-17.6	536.27	56	1.27	+710.72	167	631	.003	329
18000	280	40	-12.4	-21.2	515.79	48	.98	+688.20	160	629	.003	328
19000	282	42	-14.0	-23.5	495.46	46	.77	+667.73	154	626	.003	329
20000	283	45	-16.4	-36.2	475.70	16	.48	+646.21	146	624	.007	329

MANDATORY LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS HRS	RH PERC
346	231	20	15.7	10.6	1000	72
1777	240	31	15.3	11.6	950	80
3461	256	29	14.2	2.3	900	43
4959	264	26	11.4	4.3	850	63
7712	265	24	7.3	2.1	800	69
873	265	23	3.	0	750	66
14000	263	26	-0.1	-2.6	700	54
14015	265	29	-1.1	-18.3	650	24
14099	270	32	-5.4	-12.3	600	59
15022	276	38	-6.3	-16.1	550	57
14719	282	41	-14.2	-23.3	500	48

SIGNIFICANT LEVELS

ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS HRS	I/R %
16	220	13	15.5	10.7	1011.90	329
676	238	32	16.1	10.5	982.22	326
1019	249	32	15.2	13.0	955.46	324
2460	251	31	15.7	5.6	927.79	240
3319	250	29	14.7	2.2	890.95	274
5193	265	24	2.4	.6	743.42	241
9327	263	25	1.1	-3.2	7..45	246
13702	264	28	-1.4	-2.5	683.84	241
11499	264	29	-.6	-19.4	660.50	196
1222	266	29	-.2	-18.0	644.74	191
134	266	30	-2.1	-17.2	619.65	186
14193	270	33	-5.6	-11.9	59..50	180
14261	283	42	-15.7	-23.7	490.10	193

HAWAII-SURGE RUN AN/GRU-4
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ALTITUDE FEET	DIR DEG	SPEED KTS	TEMP DEG F	DEP PT DEG C	PRESS HRS	RH PCT	AB HUM G/H3	DENSITY G/M3	I/R %	VS KTS	SWBAR /SEC DER	
											4	8
10	220	12	17.9	11.3	1021.40	60	10.17	1.224,08	335	650	0	0
1488	230	33	17.7	10.4	976.40	95	14.97	1.142,87	343	664	.037	245
2000	250	33	16.5	11.2	942.07	71	9.94	1.127,22	312	663	.019	338
3000	260	30	14.4	11.5	908.92	82	10.20	1.094,98	306	661	.016	19
4000	268	29	12.5	9.2	876.75	60	8.63	1.063,92	291	658	.004	42
5000	270	27	10.2	7.3	849.40	82	7.82	1.034,91	279	656	.003	50
6000	272	26	8.1	5.3	819.33	64	6.91	1.005,35	267	653	.002	58
7000	270	27	6.6	1.1	789.22	60	5.13	975,71	249	651	.003	346
8000	270	30	4.8	-3.9	756.00	53	3.57	946,37	233	650	.005	298
9000	270	31	3.7	-9.0	729.10	72	4.40	914,88	202	648	.002	203
10000	280	33	1.4	-1.2	702.28	91	4.90	887,57	229	646	.005	315
11000	280	35	-0.2	-1.2	676.45	90	4.44	859,31	220	644	.003	305
12000	280	37	-2.1	-2.6	651.02	96	4.03	834,11	212	641	.003	302
13000	280	39	-4.6	-4.8	626.29	100	3.67	808,72	204	639	.004	392
14000	280	42	-6.1	-7.5	602.83	90	2.89	784,57	194	637	.005	309
15000	280	45	-7.8	-8.3	579.68	96	2.66	769,62	187	635	.003	180
16000	280	41	-11.0	-29.1	557.59	21	1.46	748,55	168	631	.002	45
17000	280	41	-10.7	99.9	535.87	999	99.99	731,13	161	631	.004	9
18000	280	43	-12.5	99.9	515.02	999	99.99	698,68	15	629	.006	391
19000	280	46	-14.3	-36.6	494.96	13	1.22	665,99	150	627	.005	328
20000	280	47	-17.1	-30.3	475.81	14	1.19	646,49	145	623	.003	392

MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS HRS	RH PCT
926	220	19	14.9	13.1	3000	61
1762	251	34	16.6	13.2	956	61
2469	260	30	13.0	11.1	906	63
3045	270	27	11.5	7.5	850	62
3795	270	26	7.6	3.3	800	75
4230	270	30	4.7	-2.0	750	58
13067	282	34	1.5	-4	700	52
12017	280	37	-7.1	-2.6	650	56
14692	287	42	-6.4	-9.1	600	63
16935	287	41	-11.7	-31.8	550	10
17096	294	45	-12.0	-36.3	500	13

SIGNIFICANT LEVELS

ALTITUDE FEET	LIN DEG	SPEED KTS	TEMP DEG C	DEP PT DEG C	PRESS HRS	I/R
10	220	12	15.2	11.3	1011.20	335
1454	241	34	17.4	16.3	970.80	343
2001	259	33	16.5	11.2	942.04	313
2700	270	27	11.2	7.3	848.45	276
3701	272	26	5.9	6.5	824.03	272
4720	275	26	6.5	-6	787.62	249
7309	277	27	6.0	1.1	770.57	292
7724	278	29	4.9	-4.3	755.03	243
9170	278	31	2.9	-0.4	724.34	232
9350	279	32	2.4	-3.3	718.91	226
9623	281	33	1.9	-0.9	712.31	226
12580	284	38	-2.0	-2.9	630.75	208
13857	286	41	-5.4	-5.6	600.14	197
14322	287	42	-7.4	-11.0	595.84	187
14354	288	42	-7.0	-12.3	594.00	186
14972	288	42	-7.0	-7.5	588.57	190
15156	288	41	-7.0	-8.5	578.50	186
15714	289	41	-11.1	-28.6	559.39	166
16734	288	41	-11.2	-33.1	540.46	162
17481	291	42	-11.7	99.9	525.70	154
17601	293	43	-13.0	-35.7	510.91	154

HAWAIIAN HUR. AN/SHM-4
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ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM HGT	AR MM	INTENSITY 0/MS	I/R %	VS KTS	SHEAR /SEC	DEC
10	250	13	2.8	17.2	1043.40	80	10.51	1192.16	352	668	0	0
1000	248	19	16.4	15.5	978.64	63	13.06	1151.36	337	605	.011	245
2000	253	21	16.2	14.9	944.49	92	12.67	1129.56	320	663	.004	302
3000	264	21	14.8	12.4	911.30	86	10.93	1085.77	311	601	.007	341
4000	278	24	13.6	7.2	879.12	65	7.76	1043.33	284	662	.010	336
5000	283	28	11.4	4.0	847.85	60	6.14	1034.22	268	657	.009	320
6000	285	32	6.4	3.5	817.48	66	6.63	1014.17	261	655	.007	289
7000	261	32	7.7	4.1	758.11	78	6.32	973.72	256	653	.004	200
8000	276	31	5.7	4.3	759.41	91	6.44	944.76	251	651	.005	175
9000	271	31	4.1	1.7	731.96	78	5.02	916.19	236	649	.005	180
10000	267	33	2.4	1.3	704.78	91	5.26	887.16	231	647	.005	221
11000	274	35	2.1	0.9	678.76	999	69.99	859.03	192	645	.008	342
12000	277	35	.5	-20.2	653.57	20	.97	831.53	191	644	.003	347
13000	277	36	-1.3	-20.8	629.18	21	.93	815.66	186	642	.002	296
14000	276	38	-2.5	-27.4	605.58	14	.57	779.13	177	641	.002	296
15000	278	38	-3.6	-33.1	582.75	8	.30	753.51	170	639	.001	287
16000	277	39	-5.8	-31.7	550.06	11	.35	730.33	165	637	.001	241
17000	277	40	-6.2	-30.4	539.24	15	.30	718.77	160	634	.002	261
18000	277	42	-11.6	-37.1	518.45	9	.21	687.85	155	631	.003	281
19000	278	44	-13.0	-29.5	498.28	23	.44	666.94	152	628	.004	297
20000	280	45	-15.0	-30.8	478.74	29	.39	645.96	147	626	.003	324

MANDATORY LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	MM HGT
987	249	15	15.0	16.6	10000	81
1034	252	21	16.5	15.0	950	91
3342	261	22	14.5	10.9	900	79
4722	285	28	11.4	4.1	650	60
5270	284	34	5.7	2.6	600	17
5220	275	31	5.2	1.7	750	79
11662	267	34	2.4	1.1	700	91
12124	277	35	.2	-20.0	650	20
14412	270	38	-2.7	-30.0	600	11
16458	277	39	-7.0	-30.0	550	14
15270	278	44	-12.0	-29.3	500	24

SIGNIFICANT LEVELS

ALTITUDE FEET	DIM DEG	SPEED KTS	TEMP DEG C	DEW PT DEG C	PRESS HRS	I/R
10	250	13	2.8	17.2	1019.20	352
1094	252	21	16.4	15.0	948.05	330
2703	260	21	15.1	13.7	921.09	318
4957	262	25	13.1	4.9	867.86	275
5578	264	34	8.7	2.9	506.32	296
7111	261	32	7.4	5.0	784.66	298
7029	277	32	5.7	4.6	764.22	253
7784	270	31	5.7	4.5	759.85	294
7584	273	31	4.8	-0.3	743.09	248
8743	273	31	4.4	1.1	736.72	238
9525	268	32	3.	1.3	717.40	244
10486	270	34	1.8	.2	694.64	227
10915	274	35	2.7	9.9	681.94	196
11951	277	35	1.9	-20.6	664.47	193
14233	276	38	-3.1	-33.2	593.32	172
15429	277	42	-11.0	-38.3	512.90	194
15917	278	44	-12.7	-29.1	501.92	198

APPENDIX D

SATELLITE IMAGERY (IR)
(1973)

SATELLITE IMAGERY (IR)



NOAA 2 ORBIT 5314, 12 DECEMBER 1973, 2120 EST

APPENDIX E

**CALCULATION OF THERMODYNAMIC VARIABLES
FROM RAWINSONDE DATA**

The equations used for calculation of thermodynamic variables from measurements of altitude, temperature and relative humidity obtained from the GMD-4, AMQ-9 rawinsonde system are summarized herein; these equations, originally developed for the GMD-2 system (Ref. 1), must be used in conjunction with the list of symbols and units provided at the end of this appendix.

Atmospheric Density, ρ

$$\rho = 348.38 \frac{P}{T_v}$$

Pressure, P

$$P = P' 10^{-(h-h')/(221.266 T_{vm})}$$

Geopotential Height, h

$$h = \frac{g_o}{9.8} \frac{r_e H}{r_e + H}$$

Virtual Temperature, T_v

$$T_v = T(1 + .376932 e/P')$$

Mean Virtual Temperature, T_{vm}

$$T_{vm} = \frac{T'_v + T_v}{2}$$

Vapor Pressure, e

$$e = 6.11 f_D 10^{7.5t/(t+237.3)}$$

Dew Point Temperature, t_d

$$t_d = \frac{237.3 \log e - 186.527}{8.236 - \log e}$$

Potential Temperature, θ

$$\theta = T \left(\frac{1000}{P} \right)^{.288}$$

Virtual Potential Temperature θ_v

$$\theta_v = T_v \left(\frac{1000}{P} \right)^{.288}$$

Absolute Humidity, ρ_w

$$\rho_w = 216.7 e/p$$

Microwave Refractive Index, n

$$n = 1 + \left[\frac{1}{T} \left(77.6P - 11e + \frac{374808e}{T} \right) \right] 10^{-6}$$

For data tabulation, use:

$$N = (n-1)10^6$$

Speed of Sound, v_s

$$v_s = 643.855 \left(\frac{T}{273.16} \right)^{0.5}$$

LIST OF SYMBOLS AND UNITS

e	vapor pressure	millibars (mb)
f_D	relative humidity expressed as a decimal	
g_o	acceleration of gravity at geographical location of the rawinsonde station	meters/seconds ² (m/sec ²)
h	geopotential height at the top of the layer bounded by h and h'	feet (ft)
h'	geopotential height at the bottom of the layer bounded by h and h'	(ft)
H	geometric altitude at the top of the layer bounded by H and H'	(ft)
H'	Geometric altitude at the bottom of the layer bounded by H and H'	(ft)
n	microwave refractive index	
N	unit of refractive index used for simplification of data tabulation	
P	pressure at geopotential height h	(mb)
p'	pressure at geopotential height h'	(mb)
r_e	radius of the earth	(ft)
t	temperature	degrees Celsius ($^{\circ}$ C)
T	temperature	degrees Kelvin ($^{\circ}$ K)
t_d	dew point temperature	($^{\circ}$ C)
T_v	virtual temperature at geopotential height h	($^{\circ}$ K)

T_v'	virtual temperature at geopotential height h'	(°K)
T_{vm}	the mean virtual temperature of layer bounded by h and h'	(°K)
v_s	speed of sound	knots
ρ	atmospheric density	grams/meter ³ (gm/m ³)
ρ_w	absolute humidity	(gm/m ³)
θ	potential temperature	(°K)
θ_v	virtual potential temperature	(°K)

REFERENCE

Daniel, O. H.: Digital Computer Reduction of AN GMD-2 Rawinsonde Data.
 Pan American World Airways, Guided Missile Range Division,
 Patrick Air Force Base, Florida, 10 May 1962.

APPROVAL

COMPENDIUM OF METEOROLOGICAL DATA FOR THE TITAN III C LAUNCH IN DECEMBER 1973

By J. Briscoe Stephens, S. I. Adelfang, and A. I. Goldford

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

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